BWR Channel Exit Quality and Void Fraction (Drift Flux)

Exit equilibrium quality, boiling height fraction and exit void fraction by the homogeneous and Zuber-Findlay drift-flux models for a boiling water reactor channel.

Method: Channel energy balance and the Zuber–Findlay drift-flux model

Input parameters

Unit system: SI

Parameter	Value	Unit
Channel pressure	7.0000	MPa
Inlet temperature (subcooled)	278.00	°C
Channel (bundle) power	5.0000	MW
Channel flow	57,600	kg/h
Channel flow area	98.000	cm²
Distribution parameter	1.1300	
Drift velocity	0.24000	m/s

Calculated results

Parameter	Value	Unit
Inlet enthalpy	1,225.8	kJ/kg
Exit enthalpy	1,538.3	kJ/kg
Exit equilibrium quality	17.999	%
Fraction of length to the start of bulk boiling (uniform heating)	13.310	%
Exit void fraction, homogeneous	81.636	%
Exit void fraction, drift flux	70.720	%
Exit mixture density (drift flux)	242.42	kg/m³
Mass flux	1,632.7	kg/(m²·s)

Notes for this case

• Zuber–Findlay: α = x/[C₀(x + (1 − x)ρ_g/ρ_f) + ρ_gV_gj/G]. Equilibrium quality ignores subcooled boiling near the boiling boundary. Water and steam properties from IAPWS-IF97.

Formula and method

$$x_e = \frac{h_{in} + Q/\dot{m} - h_f}{h_{fg}}, \quad \alpha = \frac{x}{C_0\left[x + (1-x)\rho_g/\rho_f\right] + \rho_g V_{gj}/G}$$

Variables

p	Channel pressure	Pa
T_{in}	Inlet temperature (subcooled)	K
Q	Channel (bundle) power	W
$\dot{m}$	Channel flow	kg/s
A	Channel flow area	m²
C_0	Distribution parameter	-
V_{gj}	Drift velocity	m/s
h_{in}	Inlet enthalpy	J/kg

h_{out}	Exit enthalpy	J/kg
x_e	Exit equilibrium quality	-
z_b/L	Fraction of length to the start of bulk boiling (uniform heating)	-
α_h	Exit void fraction, homogeneous	-
α	Exit void fraction, drift flux	-
ρ_m	Exit mixture density (drift flux)	kg/m³
G	Mass flux	kg/(m²·s)

Method and standards

Channel heat balance with drift-flux void fraction.

Assumptions and limits

- Steady state; uniform heating for the boiling height.

References

Channel energy balance and the Zuber–Findlay drift-flux model

Report details

Report reference	FCC-CASM-S7GY (the same inputs always give the same reference)
Generated	23 November 2026, 17:35 UTC
Calculator	BWR Channel Exit Quality and Void Fraction (Drift Flux)
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/boilers-power-plant/nuclear-power/bwr-channel-quality-void-fraction

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Reopens the calculator with the inputs of this report.